New Technologies and Approaches for Mitigating Unregulated Contaminants in Drinking Water
• **FEDERAL SAFE DRINKING WATER ACT**

A public water system provides water for human consumption through pipes or other constructed conveyances to at least 15 service connections or serves an average of at least 25 people for at least 60 days a year.

• 90 Contaminants under regulation
  • Chemical
  • Microbial
  • Radionuclides
SDWA requires EPA to make regulatory determinations for at least 5 CCL contaminants every 5 years. EPA must regulate if:

1) The contaminant may have an adverse effect on the health of persons;

2) The contaminant is known to occur or there is substantial likelihood that the contaminant will occur in public water systems with a frequency and at levels of public health concern; and

3) In the sole judgment of the Administrator, regulation of such contaminant presents a meaningful opportunity for health risk reduction for persons served by public water systems.

*SDWA Section 1412(b)(1)*
Drinking Water Regulatory Process

General Flow of Safe Drinking Water Act Regulatory Processes

- Draft CCL
  - Final CCL
    - Preliminary Regulatory Determinations
      - Proposed Rule (NPDWR)
        - Final Rule (NPDWR)
          - Six Year Review of Existing NPDWRs

- Draft UCMR
  - Final UCMR
    - Final Regulatory Determinations
      - No further action if make decision to not to regulate (may develop health advisory).

- UCMR Monitoring Results

At each stage, need increased specificity and confidence in the type of supporting data used (e.g. health, occurrence, treatment).
### 10 Cyanotoxins (Nine Cyanotoxins and One Cyanotoxin Group)

<table>
<thead>
<tr>
<th></th>
<th>total microcystins</th>
<th>microcystin-LA</th>
<th>microcystin-RR</th>
<th>microcystin-LF</th>
<th>microcystin-YR</th>
</tr>
</thead>
<tbody>
<tr>
<td>microcystin-LR</td>
<td>microcystin-LY</td>
<td>nodularin</td>
<td>cylindrospermopsin</td>
<td>anatoxin-a</td>
<td></td>
</tr>
</tbody>
</table>

### 20 Additional Contaminants

<table>
<thead>
<tr>
<th></th>
<th>germanium</th>
<th>manganese</th>
<th>alpha-hexachlorocyclohexane</th>
<th>profenofos</th>
<th>chlorpyrifos</th>
</tr>
</thead>
<tbody>
<tr>
<td>tebuconazole</td>
<td>dimethipin</td>
<td>total permethrin (cis- &amp; trans-)</td>
<td>ethoprop</td>
<td>tribufos</td>
<td></td>
</tr>
<tr>
<td>oxyfluorfen</td>
<td>HAA5(^1)</td>
<td>HAA6Br(^1)</td>
<td>HAA9(^1)</td>
<td>1-butanol</td>
<td></td>
</tr>
<tr>
<td>2-propen-1-ol</td>
<td>2-methoxyethanol</td>
<td>butylated hydroxyanisole</td>
<td>o-toluidine</td>
<td>quinoline</td>
<td></td>
</tr>
</tbody>
</table>

1. HAA5 (dibromoacetic acid, dichloroacetic acid, monobromoacetic acid, monochloroacetic acid, trichloroacetic acid); HAA6Br (bromochloroacetic acid, bromodichloroacetic acid, dibromoacetic acid, chlorodibromoacetic acid, monobromoacetic acid, tribromoacetic acid); HAA9 (bromochloroacetic acid, bromodichloroacetic acid, chlorodibromoacetic acid, dibromoacetic acid, dichloroacetic acid, monobromoacetic acid, monochloroacetic acid, tribromoacetic acid, and trichloroacetic acid).
Role of Technology

- Approach to Standard Setting – For example, Lead/Copper Rule
- Best Available Technology Determinations
- Small System Compliance Determinations
- Analytical Methods Equivalency Procedures
Example Unregulated Contaminants

GenX Chemical Structure

What is Legionella?
Welcome to the Drinking Water Treatability Database

The Drinking Water Treatability Database (TDB) presents referenced information on the control of contaminants in drinking water. It allows drinking water utilities, first responders to spills or emergencies, treatment process designers, research organizations, academicians, regulators and others to access referenced information gathered from thousands of literature sources and assembled on one site. Over time, the TDB will expand to include over 200 regulated and unregulated contaminants and their contaminant properties. It includes more than 25 treatment processes used by drinking water utilities. The literature includes bench-, pilot-, and full-scale studies of surface waters, ground waters and laboratory waters. The literature includes peer-reviewed journals and conferences, other conferences and symposia, research reports, theses, and dissertations. By adding new contaminants and by upgrading references on existing contaminants, the TDB will always be a current source of information on drinking water contaminant control. Visit the About the TDB page for more information.

The TDB offers many features leading to the Data tab which is the heart of the TDB. After selecting a contaminant (Find a Contaminant), you will find a Treatment Processes tab that will present the list of treatment processes for which literature on the control of the contaminant was located. Selecting a treatment process, you will find a Data tab, like that shown below, that presents reference information, log or percent removal, water quality conditions and treatment process operational parameters. The Help page will aid you in navigating the TDB.

Quick Links
- EPA Drinking Water Standards
- EPA Water Contaminant Information Tool (WCIT)
- EPA Contaminant Candidate List
- EPA Analytical Methods
- EPA Integrated Risk Information System (IRIS) (Risk Documents)

Getting Started

Find a Contaminant - Click here to find a contaminant within the TDB.

Find a Treatment Process - Click here to find a treatment process within the TDB.

Future Upgrades to the Drinking Water Treatability Database

Each year, as resources allow, the number of contaminants in the TDB will increase to include other regulated and unregulated drinking water contaminants. It will also upgrade information on contaminants already in the TDB to keep it current. The bottom of each page indicates when additions and upgrades were last incorporated into the TDB. Each contaminant Overview page indicates the most recent literature search date for the contaminant. View a List of Future Contaminants anticipated for the next upgrade and the anticipated upgrade date.
Technology Based Approaches
Chino, California Action on 1,2,3 TCP

- 1,2,3 – Trichloropropane is unregulated at the federal level
- California taking proactive steps to mitigate the chemical
- Granular activated carbon being used as treatment approach

Calgon Carbon Awarded $2.3 Million Water Treatment Contract for Removal of 1,2,3-TCP

PITTSBURGH, PA – 09/13/2017

Calgon Carbon Corporation (NYSE:CCC) (Calgon Carbon or the Company) announced today that the Company and RC Foster Corporation have signed a system supply contract valued at $2.3 million, under which Calgon Carbon will provide granular activated carbon (GAC) and associated equipment systems for the removal of 1,2,3-Trichloropropane (1,2,3-TCP) from groundwater in the city of Chino, CA.

Under the terms of the contract, Calgon Carbon will supply a total of 16 GAC adsorption vessels and 320,000 pounds of Filtrasorb® 400 GAC to the Benson Treatment Plant and the Eastside Treatment Plant. The systems will treat up to 5 million gallons of water per day at each site.

“Calgon Carbon has more than 30 years experience in providing GAC adsorption systems to water providers, and we are honored to have been selected by RC Foster Corporation to be its granular activated carbon and equipment supplier for this important project,” said Nora Stockhausen, VP of the Municipal and Reactivation Business Unit.

GAC removes 1,2,3-TCP from water through a process called adsorption. GAC is expected to be the Best Available Technology (BAT) for 1,2,3-TCP treatment.
### Treatment of Algal Toxins

<table>
<thead>
<tr>
<th>Cyanobacteria Cell Removal</th>
<th>Sedimentation</th>
<th>Filtration</th>
<th>Bank filtration</th>
<th>Biofiltration</th>
<th>Membranes</th>
<th>Sorption</th>
</tr>
</thead>
<tbody>
<tr>
<td>~ 90%</td>
<td>Coag/Floc/Sed</td>
<td>Likely</td>
<td>Likely</td>
<td>Effective</td>
<td>&gt; 97%</td>
<td>No</td>
</tr>
<tr>
<td>50 - 100%</td>
<td>Coag/DAF</td>
<td>Possible</td>
<td>Likely</td>
<td>&gt; 97%</td>
<td>No</td>
<td>Likely</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cyanobacteria Cell Removal</th>
<th>Sedimentation</th>
<th>Filtration</th>
<th>Bank filtration</th>
<th>Biofiltration</th>
<th>Membranes</th>
<th>Sorption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microcystin</td>
<td>Not</td>
<td>Not</td>
<td>Not</td>
<td>Possible</td>
<td>Likely</td>
<td>Effective</td>
</tr>
<tr>
<td>Expected</td>
<td>Expected</td>
<td>Expected</td>
<td>Expected</td>
<td>Likely</td>
<td>Likely</td>
<td>No</td>
</tr>
<tr>
<td>Cylindrospermopsin</td>
<td>Not</td>
<td>Not</td>
<td>Not</td>
<td>Possible</td>
<td>Likely</td>
<td>Varied</td>
</tr>
<tr>
<td>Expected</td>
<td>Expected</td>
<td>Expected</td>
<td>Expected</td>
<td>Likely</td>
<td>Likely</td>
<td>No</td>
</tr>
<tr>
<td>Anatoxin A</td>
<td>Not</td>
<td>Not</td>
<td>Not</td>
<td>Possible</td>
<td>Likely</td>
<td>Varied</td>
</tr>
<tr>
<td>Expected</td>
<td>Expected</td>
<td>Expected</td>
<td>Expected</td>
<td>Likely</td>
<td>Likely</td>
<td>No</td>
</tr>
<tr>
<td>Saxitoxin</td>
<td>Not</td>
<td>Not</td>
<td>Not</td>
<td>Possible</td>
<td>Likely</td>
<td>Varied</td>
</tr>
<tr>
<td>Expected</td>
<td>Expected</td>
<td>Expected</td>
<td>Expected</td>
<td>Likely</td>
<td>Likely</td>
<td>No</td>
</tr>
<tr>
<td>MIB and geosmin</td>
<td>Not</td>
<td>Not</td>
<td>Not</td>
<td>Possible</td>
<td>Likely</td>
<td>Varied</td>
</tr>
<tr>
<td>Expected</td>
<td>Expected</td>
<td>Expected</td>
<td>Expected</td>
<td>Likely</td>
<td>Likely</td>
<td>No</td>
</tr>
</tbody>
</table>

* Compound is well removed until carbon capacity is exhausted

## Efficacy of Oxidation Process for Algal Toxins

<table>
<thead>
<tr>
<th>Process</th>
<th>Extracellular Cyanotoxins</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Micocystin</td>
</tr>
<tr>
<td>Free chlorine</td>
<td>Moderate <em>(f(pH))</em></td>
</tr>
<tr>
<td>Permanganate</td>
<td>Effective</td>
</tr>
<tr>
<td>Monochloramine</td>
<td>Slow/no oxidation</td>
</tr>
<tr>
<td>Ozone</td>
<td>Effective</td>
</tr>
<tr>
<td>Chlorine dioxide</td>
<td>Slow/no oxidation</td>
</tr>
<tr>
<td>AOP</td>
<td>Effective</td>
</tr>
<tr>
<td>UV</td>
<td>No</td>
</tr>
</tbody>
</table>

Phytoxigene™ CyanoDTec is a molecular (DNA) based technology (Real Time PCR) that detects and quantifies the presence of Cyanobacteria, blue green algae, and their toxin producing genes in aquatic environments.
Legionella Control

- **Emerging Technology**

- **Control for Legionella in cooling towers**

Reverse Ionizer® “Clean Tech” Water Treatment

RI utilizes high-powered electromagnetic radio frequency and advanced plasma technologies to significantly soften and mitigate the formation of destructive calcium carbonate scale, corrosion and biological contaminants in the water of cooling towers systems so that ultimately, the use of harmful chemical additives can be eliminated.
Legionella Testing

Legionella pneumophila is the causative organism for most cases of Legionnaires' disease which is a severe form of pneumonia. People catch the disease by inhaling small droplets of water suspended in the air which are contaminated with the Legionella bacterium.

The management and control of Legionella bacteria in engineered water systems is essential and regulated by legislative control measures in many countries around the world.

Accepta offer two innovative in-field Legionella testing, monitoring and detection systems that are ideal for service engineers, water treatment professionals, and building services and facilities management specialists involved in the management and control of Legionella risks.

Our Legionella risk management tools include a Legionella compliance tool kit and an innovative rapid Legionella detection test kit that employs breakthrough technology for the rapid in-field detection of Legionella pneumophila serogroup 1.

Both Accepta’s compliance monitoring tool kit and rapid Legionella detection testing systems allow those responsible for managing and controlling Legionella risks, to ensure that they are taking a proactive approach to the prevention and control of this potentially fatal disease.
Pilot Study – Gilbert, IA

- Two-stage treatment approach:
  - *Aeration contactor*- biological support, oxidation of ammonia, iron, manganese and arsenic, sorption of arsenic to iron
  - *Conventional dual granular media filtration*- additional oxidation and sorption, particle removal.
- Saturated oxygen levels maintained throughout contactor
- Contactor requires minimal backwashing
- Only chemical feed is phosphate (0.3 mg PO$_4$$_4$/L).
Iowa Ammonia Occurrence

Map of ammonia levels in Iowa based on groundwater well analyses (1998–2012) provided by the State of Iowa.
Palo, Iowa Ammonia Mitigation

- EPA Developed technology
- Biological approach
- Cost/effective
- Successful mitigation of ammonia
AdEdge Technologies, Georgia USA

NoMonia Ammonia Treatment Technology

- Sustainable, cost-effective, and robust biological treatment
- Developed and patented by the USEPA (EPA Patent # US 8,029,674, October 4, 2011)
- Relies on naturally occurring bacteria present in groundwater to enhance the natural nitrification process during which, in the presence of oxygen, ammonia is converted to nitrite and then nitrate.
Federal Investment in Next Generation Water Technologies
### GenX Occurrence – North Carolina

#### Gen X Concentration in Finished Water

<table>
<thead>
<tr>
<th>Location</th>
<th>06/22/2017 results ppt</th>
<th>06/29/2017 results ppt</th>
<th>07/06/2017 results ppt</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Test America, CO</td>
<td>EPA RTP, NC</td>
<td>Test America, CO</td>
</tr>
<tr>
<td>International Paper Finished</td>
<td>690</td>
<td>523</td>
<td>140</td>
</tr>
<tr>
<td>NW Brunswick Water Treatment Plant (WTP)</td>
<td>910</td>
<td>695</td>
<td>51</td>
</tr>
<tr>
<td>Finished</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pender Co. 421 WTP Finished</td>
<td>340</td>
<td>269</td>
<td>160</td>
</tr>
<tr>
<td>CFPUA Sweeney Finished</td>
<td>1100</td>
<td>726</td>
<td>110</td>
</tr>
</tbody>
</table>

#### Gen X Concentration in Finished Water

<table>
<thead>
<tr>
<th>Location</th>
<th>06/19/2017 results ppt</th>
<th>06/26/2017 results ppt</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Test America, CO</td>
<td>Test America, CO</td>
</tr>
<tr>
<td>Bladen Bluffs Finished</td>
<td>790</td>
<td>76</td>
</tr>
</tbody>
</table>
New Models for Water Management

- Fit-for-purpose
- Treatment in distributed systems
- Does all the water need to be used need to be drinking water quality?

![Water Use Pie Chart]

Source: Benjamin D. Inskoep and Shahzeen Z. Attari
Communication Aspects
Notice The U.S. Environmental Protection Agency, through its Office of Research and Development, funded and managed, or partially funded and collaborated in, the research described herein. It has been subjected to the Agency’s peer and administrative review and has been approved for external publication. Any opinions expressed in this paper are those of the author(s) and do not necessarily reflect the views of the Agency, therefore, no official endorsement should be inferred. Any mention of trade names or commercial products does not constitute endorsement or recommendation for use.